AD-A258 544

US Army Corps
of Engineers
Construction Engineering
Research Laboratory

USACERL Interim Report FF-92/02
August 1992
Knowledge Worker Task Characterization

Building a Knowledge Base for the Knowledge Worker System

by
Beverly E. Thomas
Wayne J. Schmidt

Every daily activity of the U.S. Army depends in part on the work of *knowledge workers*—action officers who gather, process, and pass on information essential for mission accomplishment. The effectiveness of knowledge workers is often impaired by constantly shifting schedules, information overload, lack of standard automated tools, and the requirements of accomplishing necessary-but-mundane tasks such as scheduling, coordinating with others, and reporting. The U.S. Army Construction Engineering Research Laboratories (USACERL) is developing a computer-based performance support environment (PSE) called the Knowledge Worker System (KWS), which is intended to substantially reduce the problems and inefficiencies inherent in knowledge work. The objective of this phase of the research was to identify the information that must be collected to establish the rich database required to support KWS applications. It has been found that any knowledge work task may be characterized by one (or more) of 13 attributes. Similarly, the work of any functional knowledge work group may be characterized by some or all of these 13 task attributes. The information to be collected depends on the objectives of the specific application—not all applications will require data pertaining to all 13 task attributes.

The work described in this report will conclude with development of a cost-effective methodology for building a KWS database.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	August 1992	Interim

4. TITLE AND SUBTITLE

Building a Knowledge Base for the Knowledge Worker System

5. FUNDING NUMBERS

PR 4A162784
PE AT41
WU SA-AS1

6. AUTHOR(S)

Beverly E. Thomas and Wayne J. Schmidt

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Construction Engineering Research Laboratories (USACERL)
PO Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER

IR FF-92/02

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Headquarters, U.S. Army Corps of Engineers (HQUSACE)
ATTN: CEMP-P
20 Massachusetts Avenue, NW.
Washington, DC 20314-1000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Every daily activity of the U.S. Army depends in part on the work of *knowledge workers*—action officers who gather, process, and pass on information essential for mission accomplishment. The effectiveness of knowledge workers is often impaired by constantly shifting schedules, information overload, lack of standard automated tools, and the requirements of accomplishing necessary-but-mundane tasks such as scheduling, coordinating with others, and reporting. USACERL is developing a computer-based performance support environment called the Knowledge Worker System (KWS), which is intended to substantially reduce the problems and inefficiencies inherent in knowledge work. The objective of this phase of the research was to identify the information needed to establish the rich database required to support KWS applications. It has been found that any knowledge work task may be characterized by one (or more) of 13 attributes. Similarly, the work of any functional knowledge work group may be characterized by some or all of these 13 task attributes. The information to be collected depends on the objectives of the specific application—not all applications will require data pertaining to all 13 task attributes.

The work described in this report will conclude with development of a cost-effective methodology for building a KWS database.

14. SUBJECT TERMS

Knowledge Worker System (KWS)
Performance Support Environment (PSE)

15. NUMBER OF PAGES

26

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std 239-18
298-102

This work was conducted for the Directorate of Military Programs, Programming and Execution Support Office, Headquarters, U.S. Army Corps of Engineers (HQUSACE), under Project 4A162784AT41, "Military Facilities Engineering Technology"; Work Unit SA-AS1, "Knowledge Worker Task Characterization." The HQUSACE technical monitor was Mr. John Sheehey, CEMP-P.

The research was performed by the Facility Systems Division (FF) of the Infrastructure Laboratory (FL), U.S. Army Construction Engineering Research Laboratories (USACERL). The USACERL principal investigator was Ms. Beverly Thomas. Mr. Wayne Schmidt is the team leader, Management and Knowledge Integration Team, CECER-FFK. Mr. Alan W. Moore is Chief, CECER-FF. Dr. Michael J. O'Connor is Chief, CECER-FL. The USACERL technical editor was Gordon L. Cohen, Information Management Office.

The authors wish to acknowledge the considerable role played by Mr. Sheehey in describing the need for, and refining the concept of, the Knowledge Worker System.

COL Daniel Waldo Jr. is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

CONTENTS

BUILDING A KNOWLEDGE BASE FOR THE KNOWLEDGE WORKER SYSTEM

1 INTRODUCTION

Background

Every day-to-day activity of the U.S. Army relies at some stage on the work of action officers who gather, process, and pass on information essential to mission accomplishment. Much of their time is spent on mundane but necessary chores such as scheduling, coordinating with others, and reporting. The daily activities of these action officers, also referred to as *knowledge workers*, are frequently driven by continuously shifting events and dates, and ever-increasing volumes of information. Timely readjustment and response to this dynamic environment is critical, even if the knowledge worker is new on the job and does not completely understand the process or the task. In the Army this problem is compounded because turnover is high, as is the amount of information to be analyzed.

An office chief at Headquarters, U.S. Army Corps of Engineers (HQUSACE) described to researchers from the U.S. Army Construction Engineering Research Laboratories (USACERL) the specific problems of one work group. The productivity of these knowledge workers, members of a functional work group involved in the Military Construction, Army (MCA) budgeting process, was impeded by information overload, conflicting deadlines, loss of vital institutional knowledge due to turnover, and "islands of automation" serving one functional area while inaccessible to others. As USACERL studied this environment it became clear that such problems were likely to be common anywhere (in the Army or elsewhere) that a large group of knowledge workers was linked by a complex system of organizational tasking. The study led to a set of findings and principles that may apply to knowledge work groups in general. The problems common to all knowledge work groups might be substantially reduced with the help of a new category of computer software: the performance support environment (PSE).

USACERL is now developing an automated PSE, the Knowledge Worker System, to guide Army action officers through their maze of daily tasks by helping them organize, set priorities, and execute their work efficiently and effectively, in better coordination with fellow workers. This system may be used to enhance the performance of any functional work group linked by a network of microcomputers. To be effective, however, this PSE will require a rich database of procedural information, and obtaining such information is likely to be expensive. Two tasks that must precede actual development of a PSE for knowledge work, therefore, are (1) identifying the information needed to support the system, and (2) establishing a cost-effective methodology for collecting that information.

Objective

The overall objective of this research is to develop a cost-effective means of building the information base required for the Knowledge Worker System (KWS) performance support environment. The objective of this phase of the research was to identify the information that must be collected to support such a PSE.

Approach

The activities of knowledge workers involved in the formulation and justification of the MCA budget were analyzed. As problems were identified, the objectives for an MCA-specific PSE were formulated and revised. From this initial research and a study of the literature, characteristics common to all knowledge work environments were inferred. A general model for knowledge work was formulated, and the overall objectives for a universal knowledge worker PSE were defined. Thirteen specific task attributes were identified as a means of characterizing activities common to all knowledge work groups. These task attributes were then associated with the overall objectives of a knowledge work PSE.

Scope

While this research was originally spurred by the needs of a specific work group, the work is now directed toward the development of an automated system with potentially universal application to any knowledge work environment. Nevertheless, the needs of the MCA-related work group discussed above are still of central importance to this research. This group serves as the first real-world environment for refining and validating the PSE concept. However, because very little writing or research has been done on this topic, a number of different knowledge work environments ultimately will need to be analyzed for the broader premises of a knowledge work PSE to be validated with certainty.

Mode of Technology Transfer

No U.S. Army Corps of Engineers (USACE) or Army guidance documents will be impacted by the results of this study. It is anticipated that KWS will be supported and maintained by USACERL's technical assistance center or another Corps technical assistance center. Technology transfer will be accomplished through system documentation, field demonstrations, and user training activities.

2 THE PERFORMANCE SUPPORT ENVIRONMENT CONCEPT

The Need for Performance Support

The Army's administrative infrastructure is supported by action officers who define requirements to accomplish goals, allocate resources, review programs, analyze data, provide guidance, and gather and disseminate information. These action officers, or knowledge workers, add value to the information they process by using their acquired skills in concert with the leveraging power of automation.

The tasks that Army knowledge workers perform are driven by Department of Defense (DOD) deadlines, work group coordination, and *ad hoc* events. These knowledge workers must cope with large volumes of diverse information from many sources to effectively do their jobs.

Job performance is adversely affected by the nature of knowledge work. Knowledge workers are often distracted from their real goals due to the repetitive, labor-intensive chores related to accessing information and producing reports. The sheer mass of data characteristic of the work is often overwhelming.

Adding to this problem, the Army has a high personnel turnover rate. This may result from upward personnel mobility, reorganization, downsizing, or other causes. As employees are reassigned to new positions, procedural and situation-contingent knowledge leaves with them, which necessitates costly retraining of new personnel.

Objectives of a PSE for MCA Knowledge Workers

Study of the need for a knowledge work PSE initially focused on the needs of a functional work group involved in MCA budgeting activities. The major needs that emerged were taken as the objectives for a PSE targeted at MCA knowledge workers. The following seven general objectives were identified:

- *Keep track of assigned tasks, due dates, and procedural information.* KWS will cue the knowledge worker about when a product must be completed, and will outline the steps involved. The system will maintain a detailed description of the procedure for accomplishing the job.

- *Automate the work.* KWS will store the procedures for performing mundane repetitive administrative tasks (printing memos, updating reports, accessing information, etc.) and allow the knowledge worker to invoke them at will. This will enable the knowledge worker to spend more time on tasks that require professional judgment while the computer does the routine work.

- *Capture institutional knowledge.* The accumulated expertise of previous knowledge workers will be readily available through KWS. As knowledge workers enter tips, attach documents, and refine procedures for accomplishing a task, this institutional knowledge will be retained. If a task is assigned to a subordinate—or if the knowledge worker changes positions—the cumulative expertise will provide a quick understanding of how a task should be accomplished. It will also provide knowledge workers the opportunity to improve the basic processes associated with the work.

- *Keep track of schedule changes.* KWS will remind knowledge workers of deadlines and instantly communicate any schedule changes to all knowledge workers affected. Advance warning of a changed suspense can mean the difference between a job done well and a substandard deliverable.

- *Maintain a record of accomplished work.* This record can help a knowledge worker when he or she works on another version of the task or similar tasks.

- *Maintain reference documents.* Regulations, policies, previous submissions, and other reference documents will be easily accessible. This information will be kept online and associated with the task.

- *Facilitate collaborative work.* KWS will link workers whose tasks are interconnected, making it easier to share information and perform cooperative work.

It should be noted that the original objective of solving a problem for a specific work group was subsequently enlarged as described in Chapter 1. The list of objectives above is included in the broader system objectives later formulated to apply to all knowledge work PSEs, but it is not identical in all respects. Not all knowledge work groups have identical performance support needs, but it was determined that a broad set of objectives could address all problems likely to affect the performance of any given work group.

The Knowledge Worker System as a Performance Support Environment

The Knowledge Worker System (KWS) is proposed as a solution to the information overload of knowledge workers. KWS is conceived as a PSE that will guide Army action officers through their daily tasks by helping them organize, prioritize, and execute their work efficiently and effectively.

The purpose of a PSE is to take better advantage of the cognitive processing strengths of two entities: the computer, which works best on iterative processes, and the human mind, which is most effective in judgment- and creativity-based tasks. One purpose of KWS is to flatten the learning curve for newly assigned knowledge workers. The system will provide a new employee with institutional knowledge captured from action officers who previously worked in the new employee's position. With information culled from their job predecessors, new employees will more effectively be able to prioritize tasks and assemble the information necessary to complete them in a timely manner. KWS will store and access the information that represents the processes and knowledge related to a specific job description.

KWS is an example of groupware—software designed for use by collaborative work groups. The program is designed to be driven by a master calendar that lists milestones and automatically links the assignments of every employee working on each project. Dynamic scheduling capabilities will enable KWS to provide users a list of activities that should be underway on a given day. KWS will link members of a functional work group so they can send electronic mail, route documents, and query common databases.

KWS will generate an on-screen window that presents a list of a user's key task assignments or critical deadlines. When the user selects a task, another window will display the steps required to complete that activity. The user can access forms, routing sheets, or other supporting documentation relevant to the task. In this way, KWS will explain to employees what, when, and how tasks must be done. It will also automatically execute repetitive tasks, capture institutional knowledge, perform dynamic scheduling, assist in workload leveling, and support management reporting and analysis.

Functional Description of KWS

Scheduling

All aspects of KWS will be linked with a distributed schedule. This master schedule will keep track of the tasks for which each knowledge worker is responsible. Information about the tasks will be maintained in the database. A knowledge worker can use the system to view the progress of others upon whose work his or her tasks are based. The knowledge worker can also determine which other members of the work group depend on his or her work.

The KWS schedule database maintained at the work-group level may also be made available to other related work groups through the Corps of Engineers Automation Plan (CEAP) environment. This extra avenue for connectivity will improve the capability of Headquarters or other related work groups to track projects by functional area or organizational element.

Schedule information can be viewed in a variety of ways. It will be presented to the knowledge worker as a list of tasks for which the individual is responsible. A supervisor can view the same information supplemented by various criteria to get a better overview of what the work group is doing. This information can be used to assess impact of personnel shifts, manage and implement projects, and plan and monitor resource changes.

Schedule information can be used for planning and to ensure that all work is progressing as scheduled. As dates within the schedule change, the affected knowledge workers will be electronically notified. All documents, files, and executable programs associated with the tasks affected by the schedule shift will be carried along. This linkage will ensure that all information pertinent to task performance is quickly and logically accessible to the knowledge worker to whom the task is transferred.

Furthermore, when a supervisor uses KWS to reassign a task to another member of the work group, all associated information will be transferred with it. In this way, the newly assigned or temporarily tasked knowledge worker will benefit from the institutional knowledge of previous performers of the task, including their productivity tools and relevant documentation.

Automatic Execution

KWS will provide an environment for work performance. That is, KWS will offer a unified interface that ties together the whole set of productivity tools used by knowledge workers. These tools are the executable programs used by knowledge workers on a daily basis. KWS will associate the tools with the task for which they are required.

As previously discussed, one major goal of KWS is to perform many of the repetitive tasks currently done by individual knowledge workers. Since many knowledge work tasks are repetitive in nature, KWS will provide a facility for the automatic invocation of programs. This facility will allow a knowledge worker to launch external programs and supporting software from within the KWS environment.

In addition, KWS will provide methods for automating the processes of entering the steps required to perform a task and producing documents.

Information Flow

KWS will coordinate the exchange of information between itself and other programs. It will facilitate the flow of information throughout the organization, from worker to worker, program to program, and system to system.

KWS will use a distributed database server/host machine that can be accessed at multiple sites by different knowledge workers with personal computers. The communications capability provided by KWS will allow knowledge workers to access all of the database information and communicate with any other member of the work group. The users will be able to communicate with one another via an electronic message facility.

In addition, a notification "daemon," or message, will inform the knowledge worker when a remote job is completed or an important task is added to the user's list of assignments.

User Interface

KWS will provide an intuitive and consistent graphical user interface (GUI). Human factors engineering research has proven that a GUI decreases user training requirements.[1] KWS will take advantage of this technology to increase the user's effectiveness on the system, which ultimately will boost the user's job performance.

Knowledge Capture and Access

Knowledge workers can electronically "jot" down hints for improving a process while using KWS. The system will also provide a simple way to attach references to important documents.

KWS will provide the facility to relate any document to any task in the system. Besides providing a more flexible interrelated document structure, KWS will also provide automatic version control whenever a new version of an existing one is created. KWS will also provide the ability to search for any document in the system based on a keyword. A document search by similarity to the current task and the ability to archive documents are also provided.

[1] *The Benefits of the Graphical User Interface: A Report on New Primary Research* (Temple, Barker & Sloan, Inc., Lexington, MA, Spring 1990).

3 MODELS OF THE KNOWLEDGE WORK PROCESS

University of Minnesota Model

Few models of the knowledge work process exist. One model has been developed by Davis, Collins, Eierman, and Nance at the University of Minnesota. This model describes a conceptual framework for research on productivity within the knowledge work arena.[2] The model, referred to here as the University of Minnesota model (Figure 1), depicts an environment for knowledge work that includes the organizational, professional, and social context in which knowledge workers operate.

In this model, knowledge work may be viewed in an environmental context—as one overall construct within which a knowledge worker operates to achieve various goals. Alternatively, the model offers a microanalysis context that provides a view of three subconstructs of knowledge work.

One subconstruct, *work management*, addresses the self-regulatory feature of knowledge work. For some knowledge workers, work management is performed at an individual and intuitive level. Other knowledge workers rely upon an explicit system that drives task design, planning, and scheduling. Goal setting, activity selection and sequencing, information resource selection, and task planning are included as key work management variables.

Another subconstruct, *task motivation*, focuses on the forces that affect the intensity, direction, and persistence of a knowledge worker's effort. The University of Minnesota model cites task structure, deadlines, interruptions, and individual biological differences as factors that influence task motivation.

The third subconstruct, *task execution*, incorporates attentional information processing (focused problem solving), automatic information processing (work that does not require conscious thought because the performer has overlearned the task), and physical processing (operation of mechanisms that facilitate task performance).

In addition to these subconstructs, there are three major front-end inputs to the knowledge work process: task characteristics, personal resources, and information resources.

Task characteristics consist of variables such as task activities, time frame, task formalization, task ambiguity, task complexity, and task significance.

Personal resources are personal characteristics that a knowledge worker draws upon when performing work, such as domain knowledge, personality traits, individual goals, and time availability.

Information resources include external factors, such as technologies, procedural tools, and data items.

Davis et al discuss *task outcomes* as tangible results of the knowledge work process. Examples of mask outcomes include decisions, analyses, reports, lessons, plans, and other physical products.

---

[2] G. Davis, R.W. Collins, M. Eierman, and W.D. Nance, *Conceptual Model for Research on Knowledge Work*, Management Information Systems Research Center (MISRC)-WP-91-10 (University of Minnesota, February 1991).

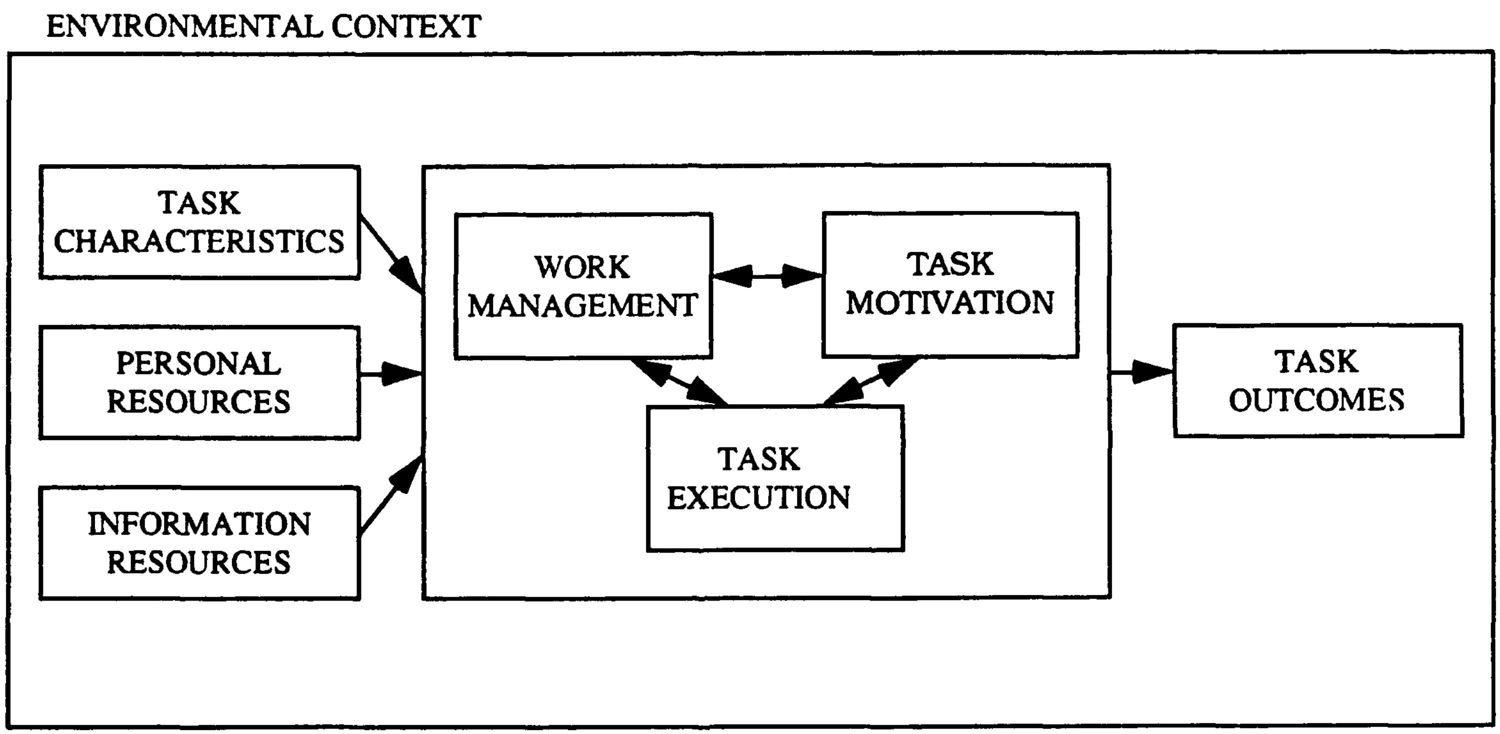

Figure 1. University of Minnesota Model of Knowledge Work.
(Source: Davis et al., 1991. Used with permission.)

USACERL Model

As stated earlier, much of the research to date has focused on the processes of knowledge work in general. This work has led to the formulation of a USACERL model of the knowledge work process. The USACERL model was originally based on study of Army knowledge workers involved in the MCA budget formulation and justification process known as planning, programming, and budgeting. However, the authors consider it to be a valid model for any other knowledge work environment as well.

The foundation for the USACERL model of knowledge work is the Stimulus-Organism-Response (S-O-R) paradigm, which has its basis in classical psychology. The S-O-R premise holds that all human activity can be understood in terms of the following sequence: a stimulus acts upon an organism (i.e., person) to evoke a response.[3] The USACERL knowledge work model is further influenced by the definition of knowledge workers as professionals who (1) collect information, (2) analyze or otherwise add value to the information, and (3) produce further information. A description of the knowledge work process has been refined as depicted in Figure 2. Each component and subcomponent of the model is described in the following sections.

Prerequisite Information

This component of the model pertains to the function of gathering information. Four elements compose the prerequisite information component.

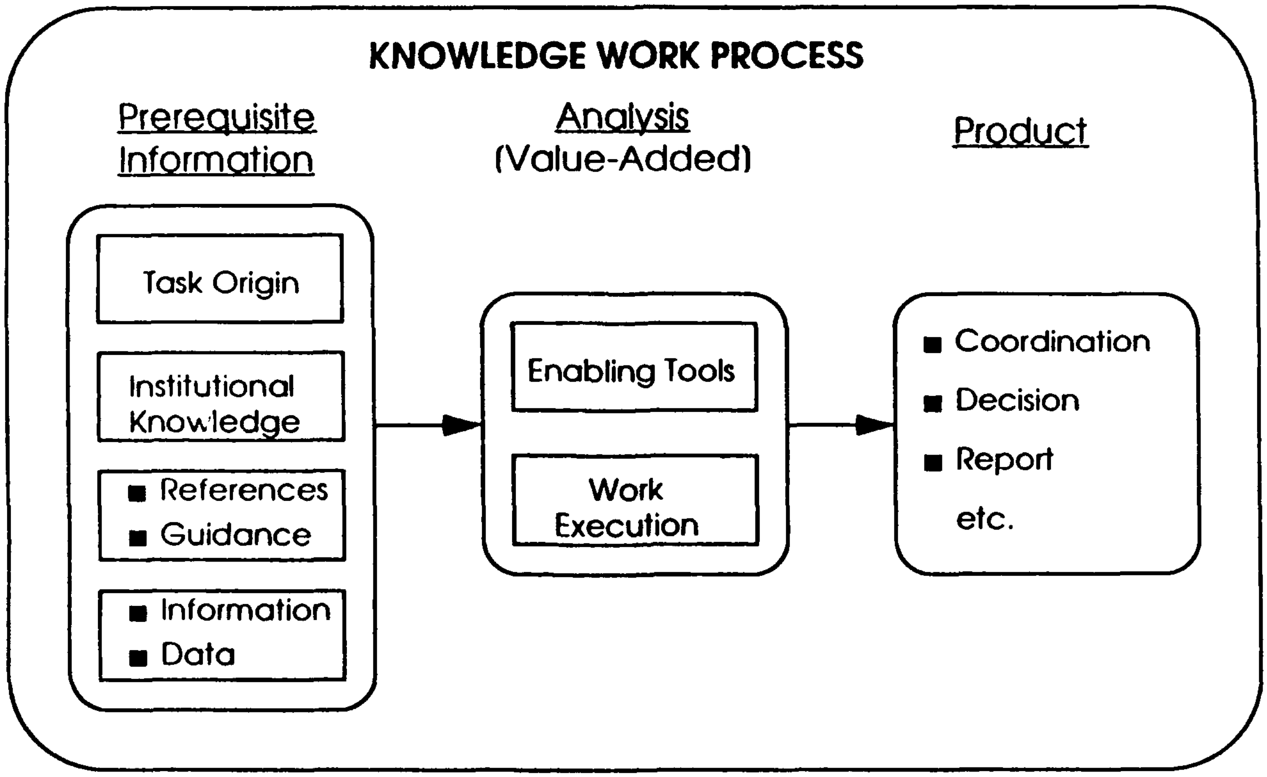

Figure 2. USACERL Model of Knowledge Work.

[3] E.J. McCormick, *Human Factors in Engineering and Design* (McGraw-Hill, 1976).

Task Origin. Information about the source of the tasking is communicated through this element. It conveys details such as whether the task is part of the organization's mission statement, whether the task has been delegated by a supervisor to a subordinate, who retains ultimate responsibility for the task, and what skill level is required to perform the task.

Institutional Knowledge. Tips, hints, procedural details, and other expert information comprise this element. In particular it refers to the "how-to" information that is accumulated through experience and often lost when a knowledge worker leaves the position.

References and Guidance. This element refers to manuals, regulations, help files, tutorials, books, instruction guides, pamphlets, guidance letters, memoranda, directives, templates, examples of previous versions of a product, and other miscellaneous documents and files.

Information and Data. The supporting facts, figures, statistics, and other types of knowledge necessary to make the calculations, reviews, judgments, and other decisions that knowledge workers generate comprise this element.

Analysis

As mentioned previously, analysis is the value-added component of knowledge work. This component corresponds with the S-O-R paradigm in terms of its emphasis on the organism. Two elements are included within this component.

Enabling Tools. Technologies such as expert systems, spreadsheets, word processors, decision support tools, and custom-designed software are examples of typical enabling tools a knowledge worker uses in performing the value-adding function.

Work Execution. This element denotes performance of the task. Knowledge work tasks entail processes such as analysis, review, planning, decisionmaking, resource allocation, policy making, and communication of information.

Product

The final component of the knowledge work process, as understood by the USACERL model, generates an information-based product such as coordination between knowledge workers, a decision, or a report. These products may be transmitted orally, printed on paper, or transmitted and stored in an electronic medium.

Knowledge Work Models vs Traditional Model

Compare the two models discussed here with the traditional Human Information Processing (HIP) model which represents the primary functions of human/machine systems.[4] The HIP model describes four basic functions: sensing (information reception), information storage, information processing and decision, and action (physical operation and communication links).

Both the University of Minnesota and USACERL models address all four of these HIP functions. A key distinction, however, is that the two knowledge work models emphasize the individual worker's

[4] See, for example, E.J. McCormick.

ability to influence the final results of the process. Further distinguishing the USACERL model from both the Minnesota and HIP models is the importance placed on institutional knowledge. The other two models address institutional knowledge only indirectly, under "Information Resources" (Minnesota) or "Information Storage" (HIP), for example. In the USACERL model, however, institutional knowledge is considered a main driver of the process. Therefore, it is considered important that any performance support environment developed for knowledge workers should facilitate the capture, retention, and accessibility of institutional knowledge—especially to assist people who are new in a position. Design and development of KWS will include a special focus on this aspect of the system.

4 TASK CHARACTERIZATION BY TASK ATTRIBUTE DEFINITION

The model that drives USACERL research into the knowledge work process was presented in Chapter 3. USACERL research into knowledge work performance support to date has focused on the ability to characterize tasks for the purpose of identifying specific information to collect when building a knowledge base. In this chapter, task attributes are proposed as a way of summarizing the information critical to the performance of knowledge work.

The task attributes outlined below were the product of a series of debriefings of MCA knowledge workers as well as a literature search. The review of literature pertaining to task analysis, decision making, and human-computer interfaces revealed that no classification system for knowledge work tasks currently exists. Early drafts of a system of task attributes were amended and refined by members of the targeted MCA work group and USACERL researchers. The product of this work was a list of 13 task attributes that pertain to knowledge work in general.

Thirteen Essential Task Attributes

Thirteen attributes have been identified to represent essential information that must be collected in the characterization of any task. These attributes are:

1. Title
2. Date due
3. Duration
4. Dependencies
5. Priority
6. Status
7. Personnel assignments
8. Motivation
9. Frequency of recurrence
10. References
11. Tools
12. Outputs
13. Steps.

The following sections define each attribute.

Title

This attribute identifies the task by name. The content of the knowledge work task should be conveyed in an abbreviated manner via the task title.

Date Due

This item states when the task must be finished. The optimal start date can be calculated using this attribute with the one following, duration.

Duration

Duration refers to the length of time required to complete the task. Duration includes three elements:

Estimated. This element projects the time required for task completion. The estimate is used when historical data are incomplete or unreliable.

Actual. The amount of time used to complete the task is recorded by this element.

Suspense vs Quality. This element records task duration in situations where a short suspense (inadequate time between notification of the task assignment and the date due) is in effect. In such a case the quality of the product may be compromised.

Dependencies

This attribute describes a task's linkage to tasks that either precede or follow it. This information is conveyed via two elements:

Predecessor. This element identifies tasks that must precede the given task.

Successor. This element identifies tasks that logically follow the task.

Priority

This item refers to the relative importance of the task. It may convey either a numeric ranking order or a narrative ranking such as "critical," "important," normal," or "low importance."

Status

This attribute describes the degree of task completion. The task slot may be filled with an indicator such as "not started," "in progress," "finished," or "dropped."

Personnel Assignments

This attribute designates who is responsible for the task. The following elements are included:

Assigned By. This element records the name of the individual who originated the task.

Skill Level. This element describes what type of personnel can perform the task. This information may take the form of a position title such as "Branch Chief," a personnel wage rating scale such as "GS-7 or above," or a descriptor such as "General Engineer," "Clerical Worker," or "Budget Analyst." This information will vary according to the nature of both the organization and the task.

Assigned To. This element records who is responsible for ensuring that the task is completed.

Performed By. This element records to whom performance of the task is delegated. This information is relevant when the person who completes the task and the person responsible for the task are different.

Motivation

This attribute conveys the reason for performing the task. The task may be motivated by a mission statement, regulation, managerial mandate, personal initiative, etc.

Frequency of Recurrence

The frequency with which the task must be repeated is reflected in this attribute. Its elements include:

Ad hoc. Indicates a one-time, special-purpose task not expected to reoccur.

Cyclic. Indicates a task that requires repetition on an annual, quarterly, monthly, daily, or other periodic basis. Cyclic tasks can be further broken down to indicate whether they occur on a fixed date, e.g., beginning or end of the cycle.

References

This attribute records the books, manuals, tutorials, help systems, regulations, job aids, letter, memoranda, reports, opinions, diagrams, and other documents that are specifically relevant to performance of the task. The attribute is divided into two major elements:

Attachments. This element includes examples of what the task previously produced, either partial or complete.

Guidance. This element consists of explanatory material that provides instructions about the task. Guidance should not be confused with *steps*, the latter being procedural information that decomposes the task into a discrete sequence of activities.

Tools

This attribute refers to any automated aids or information technology that help the worker accomplish task execution. Four elements are included:

Software. This element records the full name of any software programs pertaining to the task, including version numbers.

Data. This element lists the source of data to be processed by the software named above.

Access Path. This element lists the linkages required among workstations, communications packages, networks, databases, printers, or other devices needed to use the tools.

Authorizations. Any logins, passwords, codes, or other authorizations needed to operate the tools should be recorded under this element.

Outputs

The output attribute links products of the task, whether tangible (e.g., a report, graph, updated database, letter) or intangible (e.g., notification, denial, authorization, coordination, plan, decision). Two elements are included:

Media. This element indicates whether output is verbal, a telephone call, printed copy, electronic, a specific form, etc.

Target. This element records where the product is sent (e.g., a specific knowledge worker, office, printer, or work station).

Steps

This attribute refers to the decomposition of the task into a sequence of steps. It is the procedural information that indicates how to perform the task. This procedural information includes the tips, lessons learned, and other institutional knowledge.[5]

[5] For a summary of decomposition techniques, see D. Diaper, *Task Analysis for Human-Computer Interaction* (Ellis Horwood, 1989).

5 TASK ATTRIBUTES REQUIRED FOR A KWS KNOWLEDGE BASE

The following discussion provides considerations for selecting a set of task attributes relevant to the overall objective of the knowledge base for any KWS application. The entire set of knowledge work task attributes, as outlined in Chapter 4, may not be necessary for all knowledge bases, depending on the specific application.

Overall KWS System Objectives

For members of a work group linked by a common organizational tasking, KWS has the following major objectives:

- Task management—to provide a customized, prioritized daily list of tasks that should be performed

- Scheduling—to facilitate task management among members of the work group via a shared schedule that includes status information

- Information flow—to facilitate the sharing of documents, graphics, status information, and other information within the work group

- Information linkage—to link reference materials with the specific tasks to which they pertain

- Institutional knowledge—to capture and maintain procedural information about a task and make it available on an as-needed basis

- Automatic execution—to link automated tools directly to the tasks that they perform.

Cost Justification as an Objective

The inherent purpose of KWS is to serve as a productivity multiplier for Army knowledge workers. Ultimately, KWS must be able to enhance the knowledge worker's performance of key tasks if its development costs are to be justified. The actual demonstration of KWS effectiveness must await system development and testing. At this stage of the research, however, two possible approaches to cost justification appear promising.

The first approach is based on the hedonic wage model as applied to the cost justification of an office information system (OIS). The hedonic model assumes that an OIS can both decrease the amount of time required to complete a given task and facilitate the restructuring of work assignments. Both of these factors are postulated to result in higher efficiency. Professionals have more time to perform work in their various specialties and spend less time on routine and nonproductive tasks. The combination of the OIS and restructuring within an office can correct the misallocation of time spent by professionals on lower-value activities.[6] The premise of this hedonic wage model closely matches the purposes of a performance support environment, and would seem to apply to the KWS concept in particular.

---

[6] Peter G. Sassone and A. Perry Schwartz, "Office Information Systems Cost Justification," *IEEE Aerospace and Electronic Systems Magazine*, Vol 1 (August 1986), pp 21-26.

A second possible approach to cost justification of KWS computes the amount of time spent on direct work versus indirect work. *Direct work* is defined as activities required to generate mission-related products. *Indirect work* includes tasks that support personnel accomplishing mission-related work. In the knowledge work setting, indirect work includes such activities as copying, upward reporting, personnel management, filing, and responding to requests for information. Both types of work are necessary, but most of a worker's time should be spent on direct work. One advocate of this approach suggests that professionals should strive to spend approximately 60 percent of their time doing direct work. Comparison of the percentage of time professionals spend on direct work versus indirect work before and after introduction of an OIS may yield a useful indicator of the system's effectiveness.[7] Since this is exactly the kind of performance support that KWS will address, investigation of potential cost justification along these lines also seems promising.

Relationship of Objectives to Task Attributes

KWS objectives, including cost justification, are summarized in Table 1. The task attributes that satisfy each objective are listed. Again, it must be noted that any specific application of KWS may not require the collection and tracking of the 13 task attributes in the knowledge base. Tailoring KWS to a work group will require careful formulation of application-specific objectives, then identifying which task attributes are necessary to fulfill those objectives.

Table 1

KWS Objectives and Associated Task Attributes

System Objective	Relevant Task Attributes
Task Management	Title, Date Due, Duration, Priority, Personnel Assignment, Motivation, Status
Information Flow	Title, References, Guidance, Outputs
Scheduling	Title, Date Due, Duration, Priority, Personnel Assignment, Motivation, Status, Dependencies, Degree of Reoccurrence
Information Linkage	Title, References, Guidance, Tools
Institutional Knowledge	Title, Steps
Automatic Execution	Title, Tools, Outputs
Cost Justification	Title, Duration, Personnel Assignment, Motivation, Outputs

[7] Ray B. Helton, "Achieving White-Collar Whitewater Performance by Organizational Alignment," *National Productivity Review* (Spring 1991), pp 227-244.

6 SUMMARY

Army action officers who process information for the use of others belong to a category of professionals called knowledge workers. Job performance is adversely affected by the nature of knowledge work due to the distractions created by the many necessary but mundane administrative chores such as scheduling, coordinating with others, and reporting. The work environment is also adversely affected by information overload, conflicting deadlines, loss of institutional knowledge due to personnel turnover, and a collection of automated tools not able to address all task areas of the group. A computer-based system called a performance support environment could automate many routine administrative tasks, freeing the knowledge worker to spend more time using his or her professional skills directly on intellectual mission-oriented tasks.

Initial research on a PSE for knowledge work has concentrated on identifying all of the major attributes of knowledge work tasks. These attributes may be handled as the analogues of fields in a database: each one represents a point at which to record key information needed for tracking and executing projects from start to finish, and recording results for future reference. The integration of this information in an automated system may form the basis for a PSE applicable to any knowledge work environment.

Thirteen task attributes applicable to any kind of knowledge work have been identified. Not all attributes will apply to the task characterization of all functional work groups, however. Therefore, before beginning the construction of a PSE knowledge base for a particular work group, these task attributes should be analyzed in light of specific application objectives. Only data supporting the relevant task attributes need be collected.

On the basis of the general objectives for a knowledge work PSE, two approaches to justifying development costs seem applicable: the hedonic wage model and the direct work/indirect work criterion. The approach for measuring the cost effectiveness of the Knowledge Worker System should be decided upon and included in the list of overall system objectives.

USACERL DISTRIBUTION

Chief of Engineers
ATTN: CEHEC-IM-LH (2)
ATTN: CEHEC-IM-LP (2)
ATTN: CECG
ATTN: CERD-M
ATTN: CECC-P
ATTN: CERD-L
ATTN: CECW-P
ATTN: CECW-PR
ATTN: CEMP-P
ATTN: CEMP-E
ATTN: CEMP-C
ATTN: CECW-O
ATTN: CECW
ATTN: CERM
ATTN: CEMP
ATTN: CERD-C
ATTN: CEMP-M
ATTN: CEMP-R
ATTN: CERD-ZA
ATTN: DAEN-ZCM
ATTN: DAEN-ZCE
ATTN: DAEN-ZCI

CEHSC
ATTN: CEHSC-F 22060
ATTN: CEHSC-TT 22060
ATTN: CEHSC-ZC 22060
ATTN: DET III 79906

US Army Engr District
ATTN: Library (40)

US Army Engr Division
ATTN: Library (13)

INSCOM
ATTN: IALOG-I 22060
ATTN: IAV-DEH 22186

USA TACOM 48397
ATTN: AMSTA-XE

Defense Distribution Region East
ATTN: DDRE-WI 17070

HQ XVIII Airborne Corps 28307
ATTN: AFZA-DEH-EE

4th Infantry Div (MECH)
ATTN: AFZC-FE

Fort Pickett 23824
ATTN: AFZA-FP-E

Tobyhanna Army Depot 18466
ATTN: SDSTO-EH

US Army Materiel Command (AMC)
Redstone Arsenal 35809
ATTN: DESMI-KLF
Jefferson Proving Ground 47250
ATTN: STEJP-LD-F/DEH
Letterkenny Army Depot
ATTN: SDSLE-ENN 17201
Pueblo Army Depot 81008
ATTN: SDSTE-PUI-F
Dugway Proving Ground 84022
ATTN: STEDP-EN
Tooele Army Depot 84074
ATTN: SDSTE-ELF
Yuma Proving Ground 85365
ATTN: STEYP-EH-E
Tobyhanna Army Depot 18466
ATTN: SDSTO-EH
Seneca Army Depot 14541
ATTN: SDSSE-HE
Aberdeen Proving Ground
ATTN: STEAP-DEH 21005
Sharpe Army Depot 95331
ATTN: SDSSH-E
Fort Monmouth 07703
ATTN: SELFM-EH-E
Savanna Army Depot 61074
ATTN: SDSLE-VAE

Rock Island Arsenal
ATTN: SMCRI-EH
ATTN: SMCRI-TL
Watervliet Arsenal 12189
ATTN: SMCWV-EH
Red River Army Depot 76102
ATTN: SDSRR-G
Harry Diamond Lab
ATTN: Library 20783
White Sands Missile Range 88002
ATTN: Library
Corpus Christi Army Depot
ATTN: SDSCC-ECD 78419

FORSCOM
ATTN: Facilities Engr (12)
Fort Bragg 28307
ATTN: AFZA-DE
Fort Campbell 42223
ATTN: AFZB-DEH
Fort McCoy 54656
ATTN: AFZR-DE
Fort Stewart 31314
ATTN: AFZP-DEF
Ft Buchanan 00934
ATTN: Envr Office
Ft Devens 01433
ATTN: AFZD-DE
Fort Drum 13602
ATTN: AFZS-EH-E
Fort Irwin 92310
ATTN: AFZJ-EH
Fort Hood 76544
ATTN: AFZF-DE-AES Engr
Fort Meade 20755
ATTN: AFKA-ZI-EH-A

6th Infantry Division (Light)
ATTN: APVR-DE 99505
ATTN: APVR-WF-DE 99703

National Guard Bureau 20310
ATTN: Installations Div

Fort Belvoir 22060
ATTN: CETEC-IM-T
ATTN: CECC-R 22060
ATTN: Engr Strategic Studies Ctr
ATTN: Water Resources Support Ctr

USA Natick RD&E Center 01760
ATTN: STRNC-DT
ATTN: DRDNA-F

TRADOC
ATTN: DEH (13)
Fort Monroe 23651
ATTN: ATBO-G
Carlisle Barracks 17013
ATTN: ATZE-DIS
Fort Eustis 23604
ATTN: DEH
Fort Chaffee 72905
ATTN: ATZR-ZF
Fort Sill 73503
ATTN: ATZR-E

US Army Materials Tech Lab
ATTN: SLCMT-DEH 02172

WESTCOM 96858
ATTN: DEH
ATTN: APEN-A

SHAPE 09705
ATTN: Infrastructure Branch LANDA

Area Engineer, AEDC-Area Office
Arnold Air Force Station, TN 37389

HQ USEUCOM 09128
ATTN: ECJ4-LIE

AMMRC 02172
ATTN: DRXMR-AF
ATTN: DRXMR-WE

CEWES 39180
ATTN: Library

CECRL 03755
ATTN: Library

USA AMCOM
ATTN: Facilities Engr 21719
ATTN: AMSMC-IR 61299
ATTN: Facilities Engr (3) 85613

USAARMC 40121
ATTN: ATZIC-EHA

Military Traffic Mgmt Command
ATTN: MTEA-GB-EHP 07002
ATTN: MT-LOF 20315
ATTN: MTE-SU-FE 28461
ATTN: MTW-IE

Fort Leonard Wood 65473
ATTN: ATSE-DAC-LB (3)
ATTN: ATZA-TE-SW
ATTN: ATSE-CFLO
ATTN: ATSE-DAC-FL

Military Dist of WASH
Fort McNair
ATTN: ANEN 20319

USA Engr Activity, Capital Area
ATTN: Library 22211

Norton AFB 92409
ATTN: Library

US Army ARDEC 07806
ATTN: SMCAR-ISE

Charles E Kelly Spt Activity
ATTN: DEH 15071

Engr Societies Library
ATTN: Acquisitions 10017

Defense Nuclear Agency
ATTN: NADS 20305

Defense Logistics Agency
ATTN: DLA-WI 22304

Walter Reed Army Medical Ctr 20307

416th Engineer Command 60623
ATTN: Gibson USAR Ctr

Naval Facilities Engr Command
ATTN: Facilities Engr Command (8)
ATTN: Division Offices (11)
ATTN: Public Works Center (8)
ATTN: Naval Constr Battalion Ctr 93043
ATTN: Naval Civil Engr Laboratory (3) 93043

US Army HSC
Fort Sam Houston 78234
ATTN: HSLO-F
Fitzsimons Army Medical Ctr
ATTN: HSHG-DEH 80045

Tyndall AFB 32403
ATTN: AFESC Program Ofc
ATTN: Engrg & Srvc Lab

Chanute AFB 61868
ATTN: 3345 CES/DE

USA TSARCOM 63120
ATTN: STSAS-F

American Public Works Assoc. 60637

US Army Envr Hygiene Agency
ATTN: HSHB-ME 21010

US Gov't Printing Office 20401
ATTN: Rec Sec/Deposit Sec (2)

Nat'l Institute of Standards & Tech
ATTN: Library 20899

Defense Tech Info Center 22304
ATTN: DTIC-FAB (2)

238
08/92

This publication was reproduced on recycled paper.